Chapter 6 – Resource Plan Results

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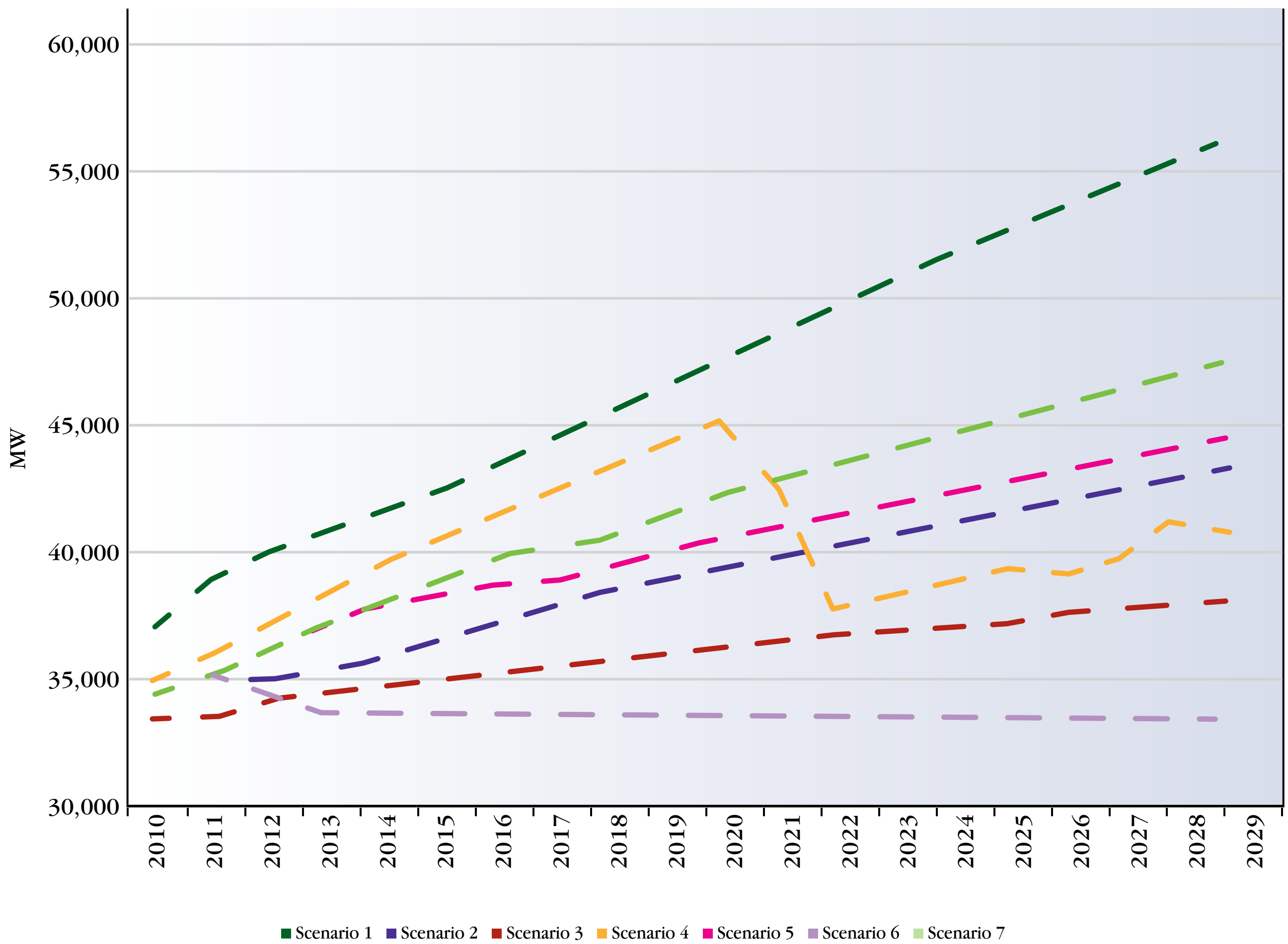
6 Resource Plan Results

6.1 Firm Requirements and Capacity Shortfall

A brief overview of the capacity needs studied in the IRP is presented in Chapter 3 for the IRP baseline case (see Section 3.3 and Figure 3-7). This section will review the capacity shortfall identified in each of the five planning strategies to set the context for the review of the expansion plans produced by evaluating each of these strategies across the seven scenarios.

As discussed in Chapter 5, each of the scenarios describes a different plausible future in which TVA may have to operate. The key attributes of each scenario are translated into a forecast of firm requirements (demand plus reserves) that is used to identify the resulting capacity shortfall that will determine the overall need for power and drive the selection of resources in the capacity planning model. Figure 6-1 contains the firm requirements forecasts for all seven scenarios:

Figure 6-1 – Firm Requirements by Scenario



Firm requirements are greatest in Scenario 1 (the highest load growth scenario) and lowest in Scenario 6 (growth in this scenario is flat to slightly negative). The remaining scenarios fall within this bandwidth and generally display a smooth growth trend, with the exception of Scenario 4 (the game-changing technology scenario). Scenario 4 contains a dramatic drop in load in 2021 to reflect the rapid commercialization of alternative technologies.

The shape of the firm requirements curves will influence the type and timing of resource additions in the strategies, especially in Scenario 4 where the dramatic drop in load will tend to reduce or eliminate resource additions in the later years of the planning study. The timing of any additional resources is also a function of the existing system capacity (see Chapter 1) and the impact of the defined model inputs for each strategy (defined model inputs are discussed in Section 5.3). Figure 6-2 summarizes the range of the capacity shortfall by the end of the study period (negative capacity shortfalls indicate a surplus). The range of the capacity gap in this figure is based on the maximum shortfall as computed in Scenario 1 and the minimum shortfall (surplus) as computed in Scenario 6.

Figure 6-2 – Range of Capacity Gaps by Strategy

Strategy	Max Capacity Gap (MW)	Min Capacity Gap (MW)
A	18,000	(4,800)
B	20,000	(3,000)
C	17,000	(6,000)
D	19,000	(4,000)
E	18,000	(5,000)

This range of capacity shortfalls will produce a wide range of expansion plans across the 35 portfolios developed in the IRP study.

6.2 Expansion Plans

As discussed in the previous chapter, TVA's capacity optimization analysis will solve for the best plan (least cost defined as the plan with the lowest present value of revenue requirements) based on the amount and timing of the capacity shortfall. This section presents a review of the portfolios produced by each of the planning strategies. These portfolios will be presented graphically as cumulative capacity additions by resource type. In order to display the portfolios from a given strategy for all seven scenarios, the results are shown in five-year increments over the study period.

Figures 6-3 through 6-7 present the 35 portfolios in the IRP study grouped by strategy. The results shown for Strategy A (Figure 6-3) indicate that expansion is virtually all purchased power, consistent with the attributes of that strategy. The general pattern of the amount of resource additions is also consistent with the assumptions that define each of the scenarios:

- The largest amount of resource additions will occur in Scenario 1.
- Scenario 7 (the Spring 2010 Baseline scenario) requires an average amount of new resources over the study period.

- Scenario 3 and Scenario 6 will have the least amount of resource additions – in fact, in most cases Scenario 6 will not require any new resources.
- Small amounts of new resources are added in Scenarios 2 and 5.
- In Scenario 4, no resources are added after 2020, consistent with the dramatic drop in load beginning in 2021.

Referring to Figure 6-3, the expansion plan for Strategy A also shows resources other than purchased power being added during the study period. These charts (as shown in Figures 6-3 through 6-7) reflect the contributions from TVA Board approved projects that are part of the expansion plan (the addition of the second unit at the Watts Bar nuclear plant and the combined cycle plant at the John Sevier site), as well as the impacts of the defined model inputs (particularly the capacity associated with the renewable resource portfolios and the avoided capacity value from EEDR). Figure 6-8, on page 110, shows the range of capacity additions by type across all the strategies.

Figure 6-3 – Limited Change in Current Resource Portfolio (Strategy A) Capacity Additions by Scenario

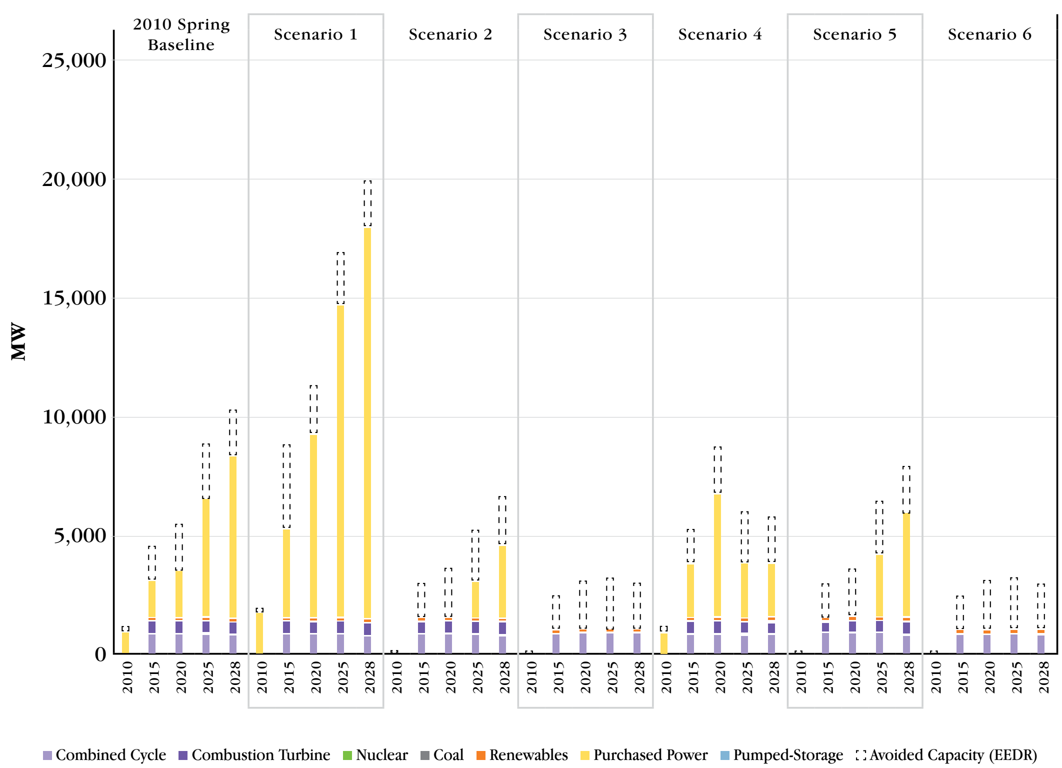


Figure 6-4 – Baseline Plan Resource Portfolio (Strategy B) Capacity Additions by Scenario

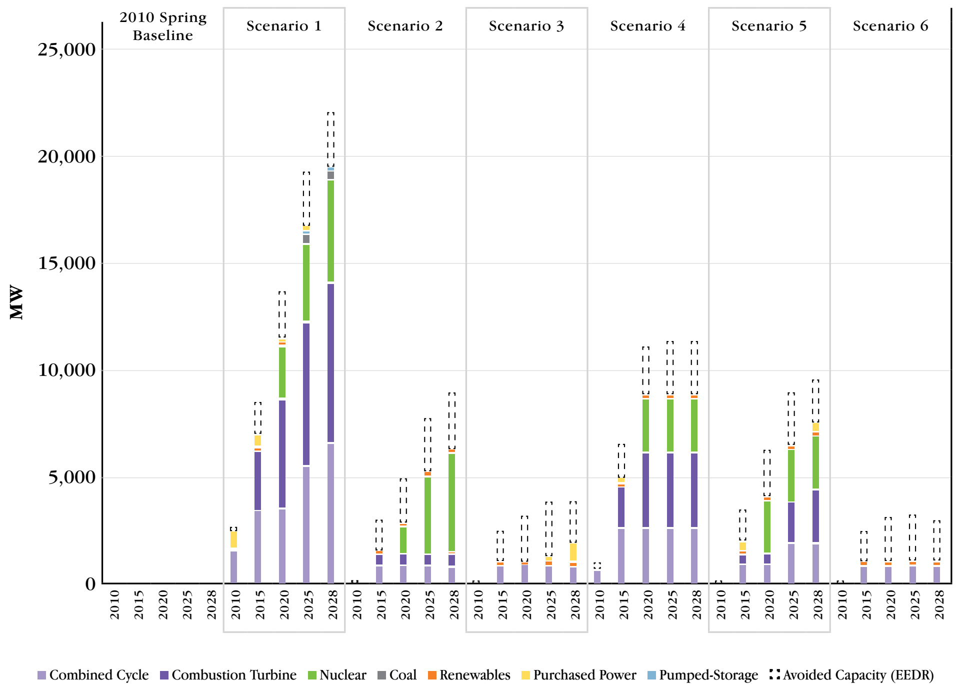


Figure 6-5 – Diversity Focused Resource Portfolio (Strategy C) Capacity Additions by Scenario

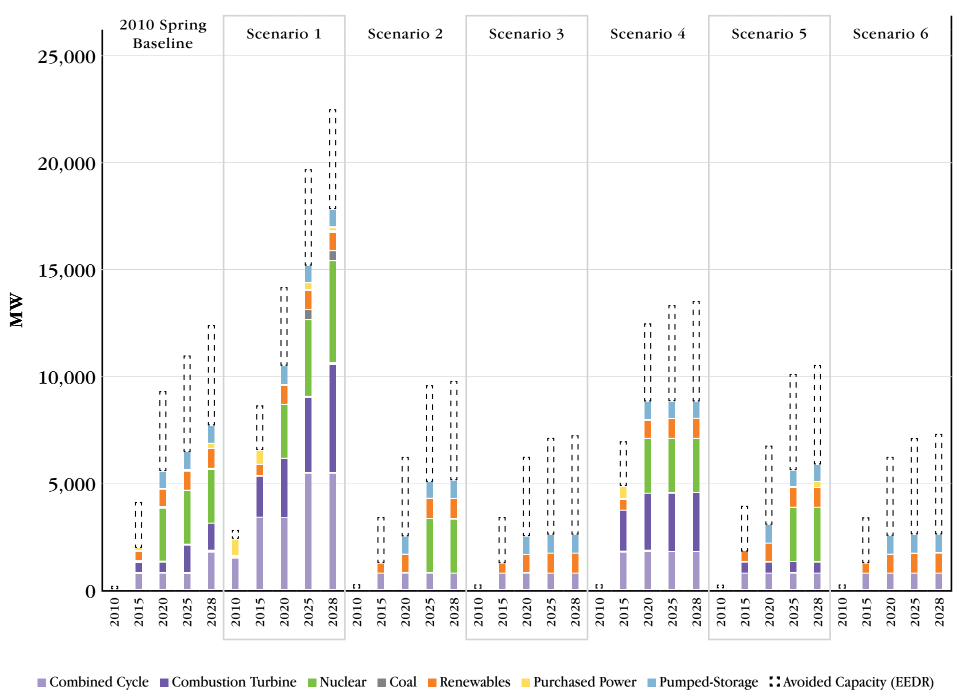


Figure 6-6 – Nuclear Focused Resource Portfolio (Strategy D) Capacity Additions by Scenario

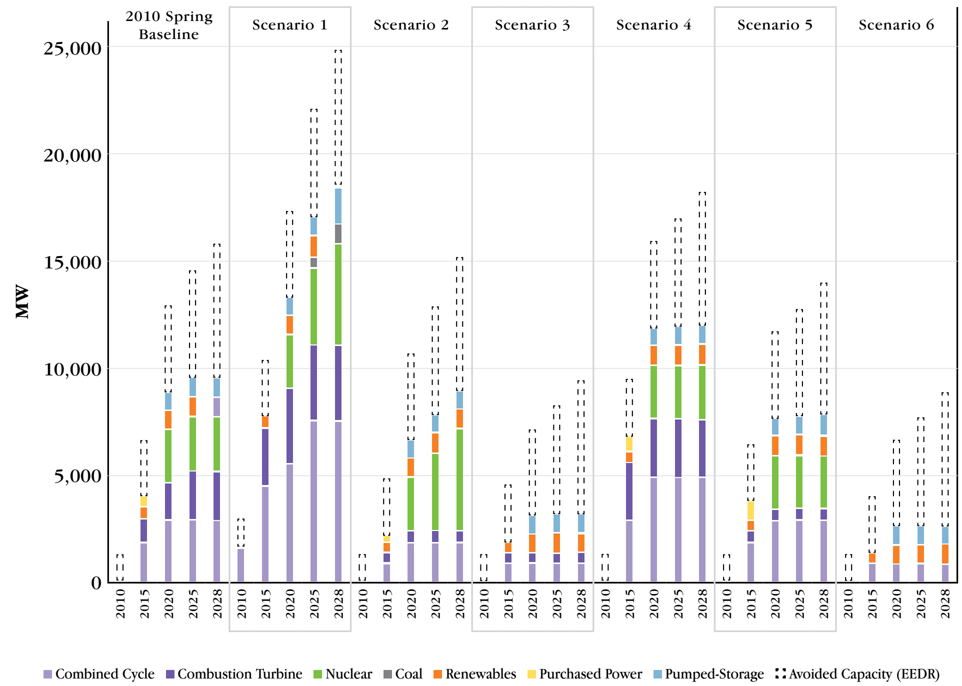


Figure 6-7 – EEDR and Renewables Focused Resource Portfolio (Strategy E) Capacity Additions by Scenario

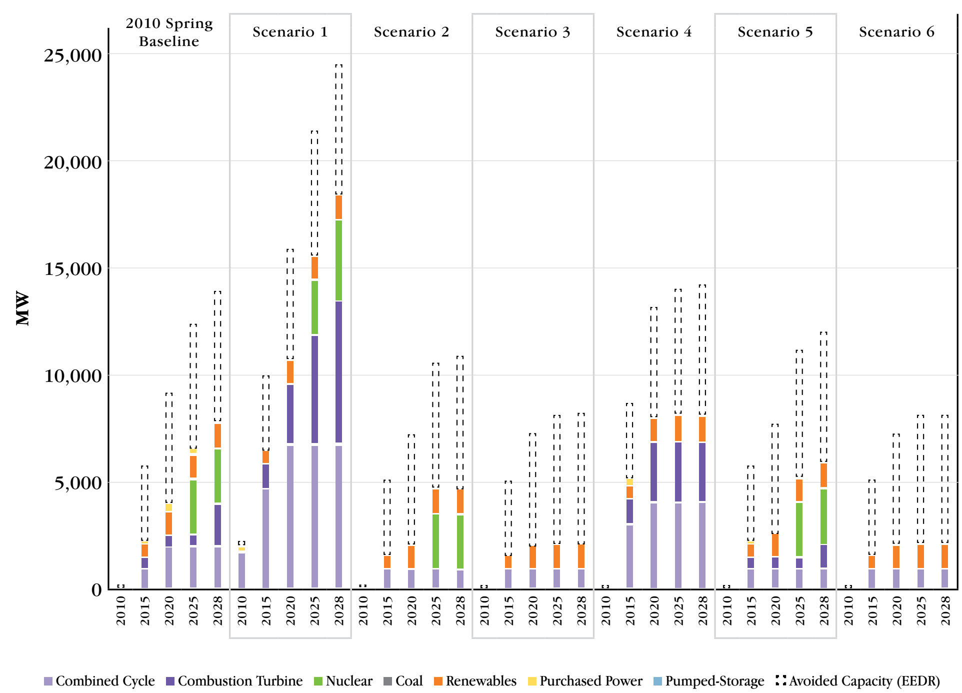


Figure 6-8 – Capacity Additions by 2029

Type	Minimum (MW)[2]	Maximum (MW)[3]
Nuclear	0	4,754(4)
Combustion Turbine	0	8,092 (11)
Combine Cycle	0	6,700 (7)
IGCC	0	934 (2)
SCPC	0	800 (1)
Avoided Capacity (EEDR)[4]	1,905	6,361
Renewables[4]	160	1,157
Pumped-storage[4]	0	850
Fossil Layups[4]	0	7,000

Notes:

1 – Values shown are for dependable capacity at the summer peak. Nameplate capacity of renewables range from 1,300 to 3,500 MW

2 – Minimums exclude Board-approved projects (WBN 2, JSFCC, and Lagoon Creek)

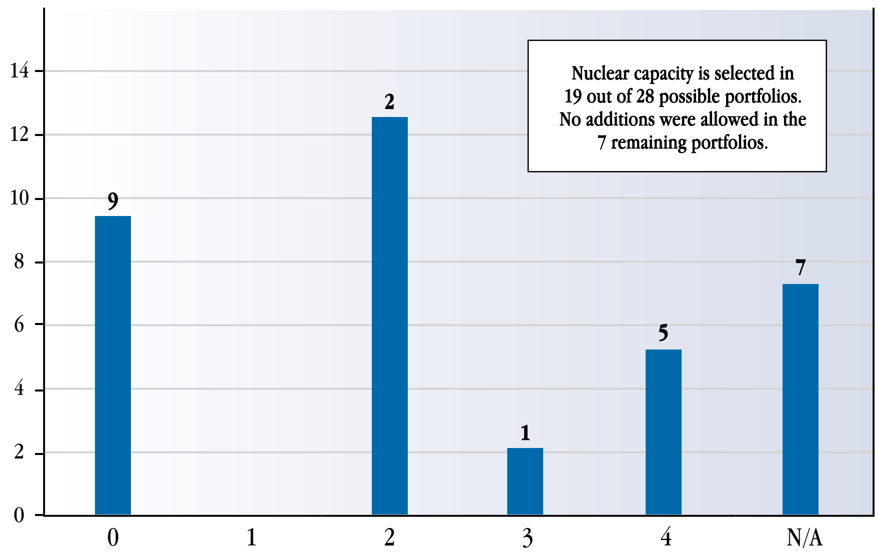
3 – Number of units shown in ( )

4 – Defined model input

To provide an alternative view of the expansion plan results, a set of histograms was developed that presents data on frequency of selection for key resource types across the 35 portfolios. Figures 6-9 through 6-12 are plots of the number of portfolios that contain a certain number of nuclear, coal, combined cycle or combustion turbine units.

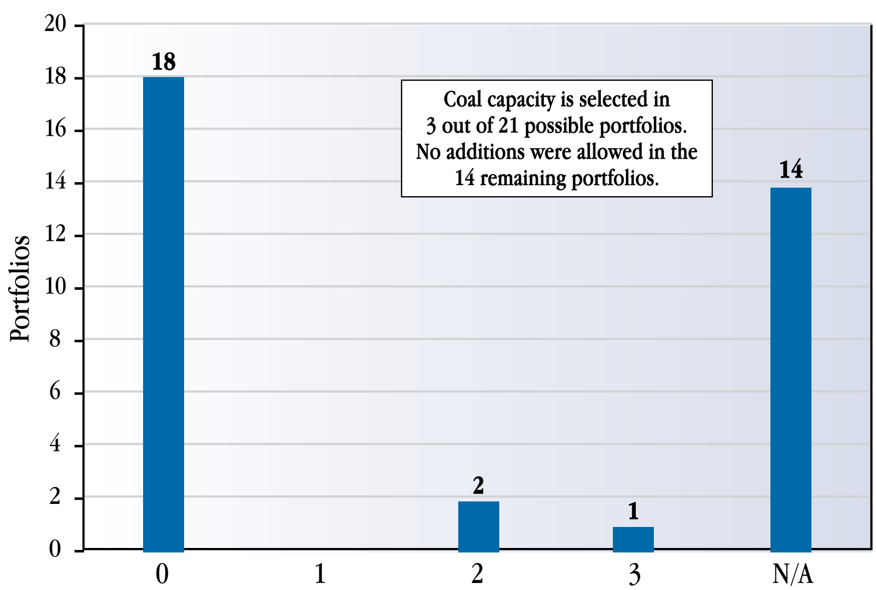
Nuclear capacity beyond Watts Bar 2 is prominent throughout analysis results, as shown in Figure 6-9. At least two nuclear units (and up to four) are added in 19 of 28 possible portfolios, and the first nuclear unit is added between 2018 and 2022. Nuclear was not selected for portfolios in scenarios with nearly flat load growth, and in one strategy nuclear was not a permitted resource option.

Figure 6-9 – Number of Nuclear Units Added



Coal capacity additions are very infrequent (see Figure 6-10). Integrated Gasification Combined Cycle (IGCC) units with carbon capture were selected after 2025 in just 3 of 21 possible portfolios. Supercritical Pulverized Coal (SCPC) with carbon capture was added in only 1 of 21 possible portfolios, and two strategies do not permit additional coal-fired units at all by design.

Figure 6-10 – Number of Coal Units Added



Combined cycle capacity added ranged from 0–6,700 MW (7 units) as shown in Figure 6-11 (potential acquisitions of IPP projects are included in the capacity additions shown). No combined cycle capacity was selected in 13 of 28 possible portfolios. As illustrated in Figure 6-12, on the following page, combustion turbine capacity additions ranged from 0–8,000 MW (11 units), and the majority of portfolios that selected combustion turbine capacity added just a single unit. Natural gas capacity (CT/CC) was not selected for portfolios in scenarios with nearly flat load growth or scenarios with the largest avoided capacity from EEDR.

Figure 6-11 – Number of Combined Cycle Units Added

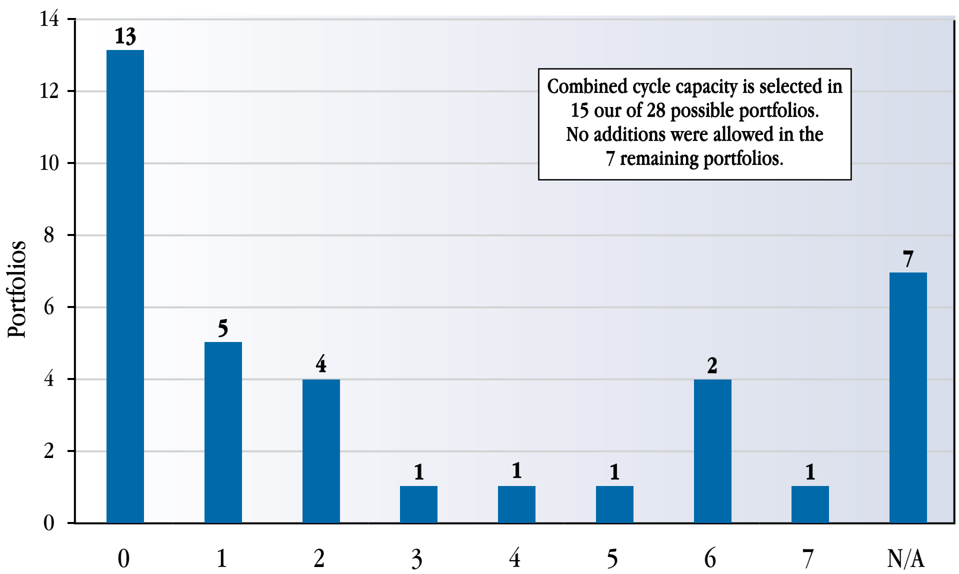
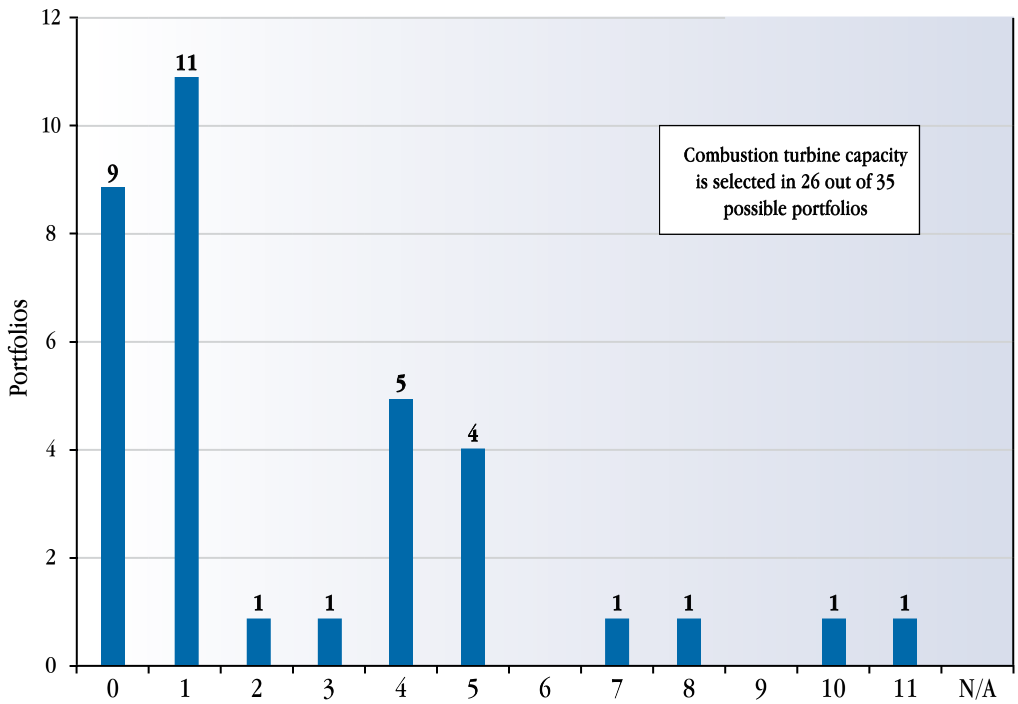


Figure 6-12 – Number of Combustion Turbine Units Added



6.3 System Energy Mix

Figure 6-13 lists the maximum and minimum percentage contributions to total energy production by type in 2025. Values represent the highest/lowest percentages for each type and are not from a single portfolio.

Figure 6-13 – Range of Energy Production by Type in 2025 (GWh)

Type	Minimum	Maximum
Combined Cycle	0%	13%
Combustion Turbine	0%	3%
Nuclear	27%	47%
Coal	24%	47%
Renewables	2%	8%
EEDR (savings)	2%	11%

Nuclear and coal have the greatest swings in percentage contribution to total energy. Nuclear actually overtakes coal and produces the greatest percentage of total energy in the majority of scenario/planning strategy combinations (Strategy A is an exception and coal remains the largest energy producer in that strategy).

6.4 Plan Cost and Risk

A comparison of the expected value of PVRR by scenario is shown in Figure 6-14. Scenario 1 results in the highest value of PVRR, while the lowest PVRR values are in Scenario 6. Within each scenario, Strategy D generally produces the highest cost portfolios due to the larger amount of fossil layup capacity that must be replaced by new resources. Strategy A results in the next highest cost set of portfolios, caused primarily by the higher level of coal-fired capacity in that strategy that is in turn exposed to more CO_2 compliance costs. Strategy C produces the lowest PVRR values in six of the seven scenarios.

Figure 6-14 – Expected Value of PVRR by Scenario

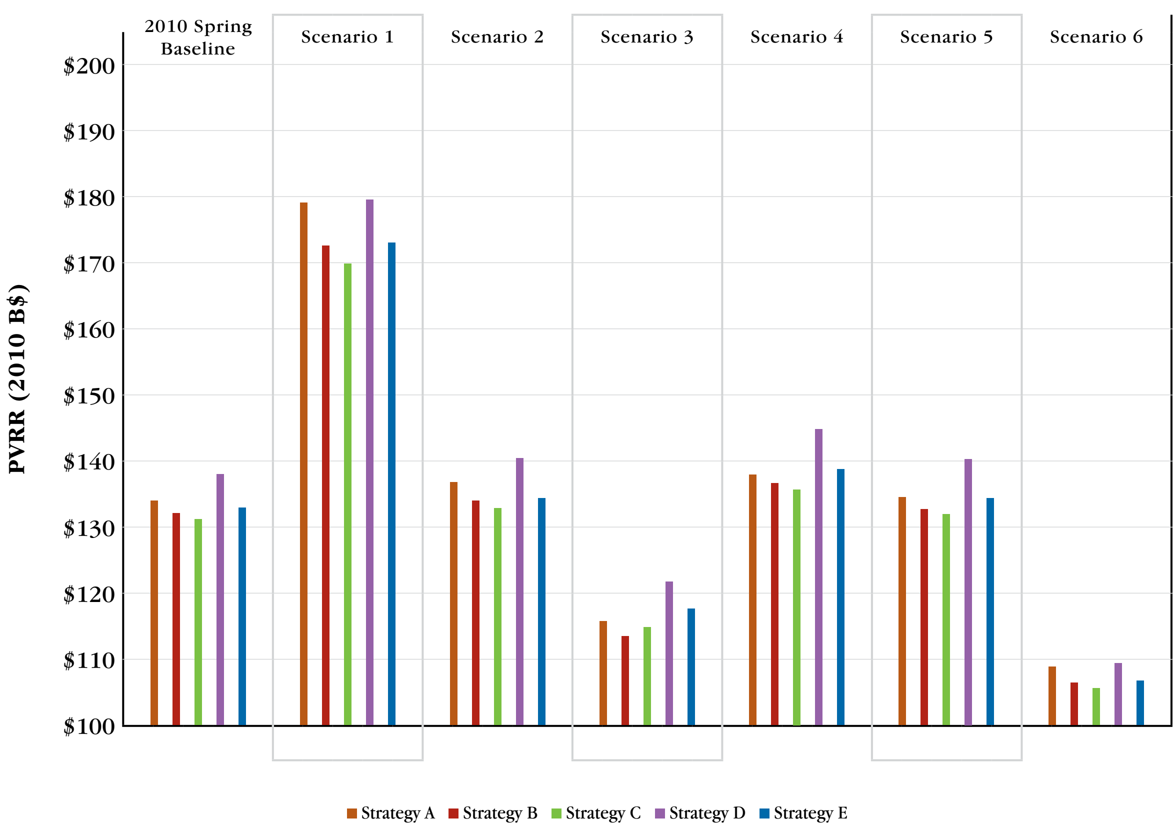
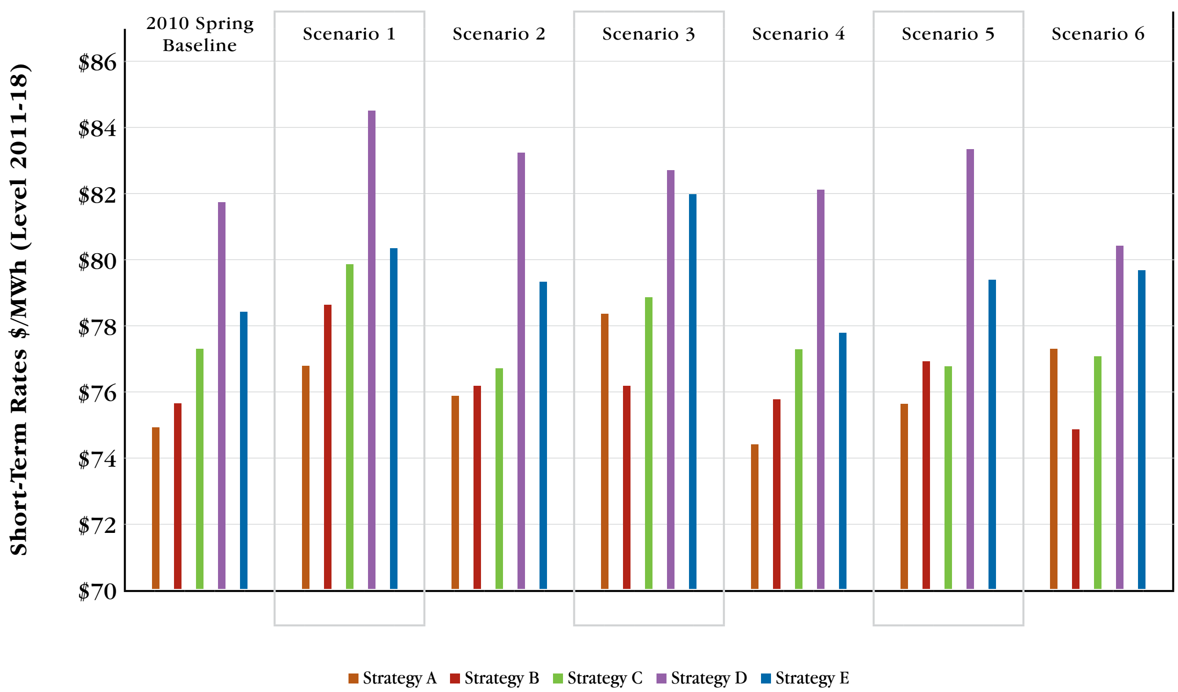


Figure 6-15 presents the short-term rate impacts (average system costs) by scenario. The strategy with the highest expected value of short-term rates is Strategy D because this strategy has the most new capacity additions in the 2011–2018 period. Strategy A has the lowest short-term rate values in five of the seven scenarios because no new capacity is added in any portfolios in that strategy; the exceptions (Scenario 3 and Scenario 6) are the result of higher CO_2 compliance costs driving up the cost of the coal-heavy portfolios in Strategy A in those scenarios.

Figure 6-15 – Expected Values for Short-Term Rates by Scenario



Figures 6-16 and 6-17, on the following page, compare the two risk metrics for the planning strategies. In general, lower ratios indicate less risky portfolios based on the probability distributions of the portfolio PVRR values. The relative relationship across the scenarios for both the risk ratio and the risk/benefit ratio are consistent: the highest values occur in Scenario 1; the risk ratio is lowest in Scenario 3; and the risk/benefit ratio is lowest in Scenario 6. In both cases, these low values are primarily caused by the much lower load forecasts in those scenarios that result in lower PVRR values with narrower probability distributions. Strategy A has the highest risk profile (represents the most risky strategy) in five of seven scenarios caused by the retention of coal-fired capacity; and Strategy C is the least risky strategy in six of the seven scenarios due to the generally balanced resource mix in the portfolios produced in that strategy.

Figure 6-16 – PVRR Risk Ratio by Scenario

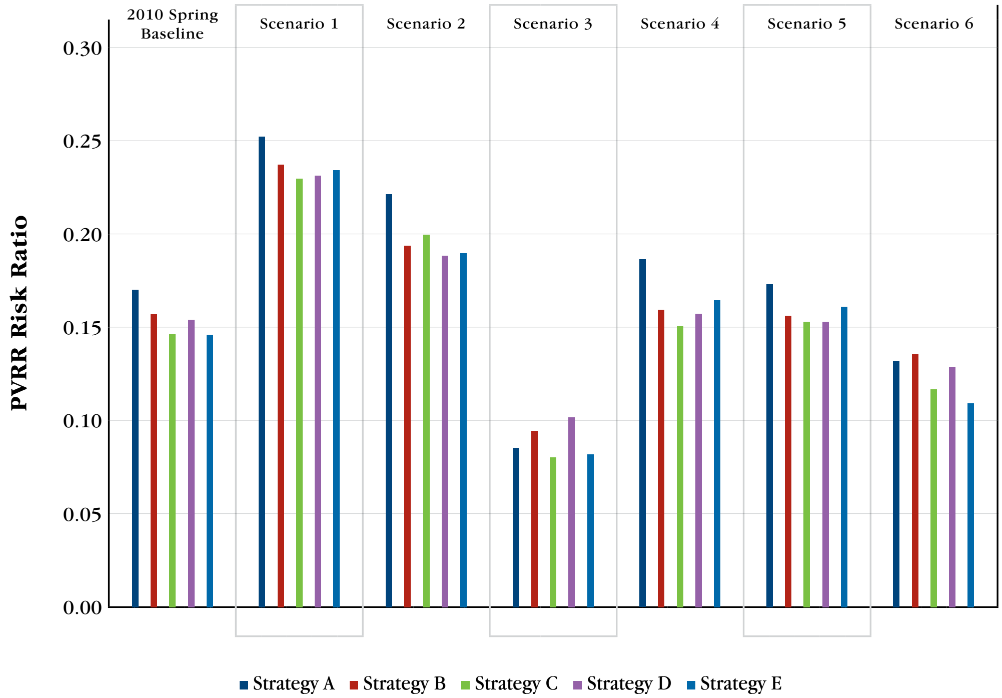


Figure 6-17 – PVRR Risk Benefit by Scenario